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TEST REPORT: SHOCK TEST OF THE ELECTRON/PROTON SPECTROMETER STRUCTURAL TEST UNIT

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TEST REPORT: SHOCK TEST OF THE ELECTRON/PROTON SPECTROMETER STRUCTURAL TEST UNIT

INTRODUCTION

On Thursday, September 9, 1971 the Structural Test Unit of the EPS was taken to Bldg. 15, NASA Manned Spacecraft Center to be subjected to the shock test requirement of MIL-STD-810B Method 516.1, Procedure I as called for in LEC Document EPS-435, Verification Plan for Electron-Proton Spectrometer, Appendix E.

PURPOSE

The purpose of the shock test was to verify the structural integrity of the EPS design and to obtain data on the shock response of the electronics and electronics housing.

DESCRIPTION

The EPS Structural Test Unit consists of dummy electronics mounted in a 'flight-type' electronic housing which is in turn mounted, via vibration isolators inside an outer housing. Figure 1 shows the mounting arrangement.

The unit was mounted in a simple box fixture and subjected to a 20 g, 11 millisecond duration terminal sawtooth shock pulse as shown in Figure 3a. This pulse was induced 3 times in each direction for each of the 3 mutually perpendicular axes of the test items (see Figure 2) for a total of 18 shocks.

Responses of the dummy boards were monitored in the 'R' axis, together with the electronic housing. The top plate was monitored in all 3 axes. The test fixture precluded monitoring the outer housing responses.

RESULTS

Typical responses of the above locations for each axis are shown in Figures 3 and 4. Visual monitoring showed no undue movement of the electronic package within the outer housing, and no audible indication of contact between inner and outer housing was noted (see appendix). Responses shown are maximum measured.

CONCLUSION

Visual examination of the test item showed no failures, loose components, etc. and comparison of the results of monitoring the response levels indicated no problem areas. Hence, the test was considered to have satisfactorily fulfilled its purpose.

APPENDIX

On the structural model, the minimum clearances were:

between electronics and mounting flange = .188"

between isolator pocket flange & bracket = .169"

The calculated response and deflection for a vibration isolation system with a natural frequency of 45 Hz subjected to the test shock is:

Max. acceleration = 23.8g.

Max. deflection = .115"

The monitored shock response is only 50-65 percent of the calculated response of the mount. It is felt that this may be due to the non-linearity of the mount system; the mounts were unmatched and of varying stiffnesses and natural frequency. Additionally, there would be some friction damping within the electronics package assembly between the mounts and the edge of the top plate, where the response was monitored.

If the natural frequency of the mounts were lower than 45 Hz, this would reduce the shock amplification and transmissability considerably, sufficient to account for the major part of the variation of the anticipated response. The rest of the discrepancy could well be accounted for by a reduction in the shock input during testing. No permanent record of this input was taken during the testing.

For example, assuming:- 35 Hz natural frequency.
18 g peak pulse
damping ratio $\approx .2$

$$\frac{\text{Ratio of shock pulse duration}}{\text{Natural period of system}} = \frac{.011}{.02857} = .385$$

$T_s = .75$ and $H_s = .7$

g response = 18 x .75 = 13.5 g

$$\Delta_{st} = \frac{18 \times 386}{(2\pi f_n)^2} = \frac{175.99}{35^2} = .143''$$

and $\delta_{max} = .143 \times .7 = .1005''$ (Ref. 1)

The above calculations show that a combination of changes in the natural frequency of the mount, shock pulse level and damping ratio would lower the response level down toward the response level measured by the test article instrumentation.

Equally, however, the lowering of the response level may be due to attenuation of the shock pulse through the mounting fixture, and the frictional damping within the test article structure.

Ref 1. Passive Shock Isolation, Pt. II, J. E. Ruzicka, "Sound and Vibration", Sept. 1970

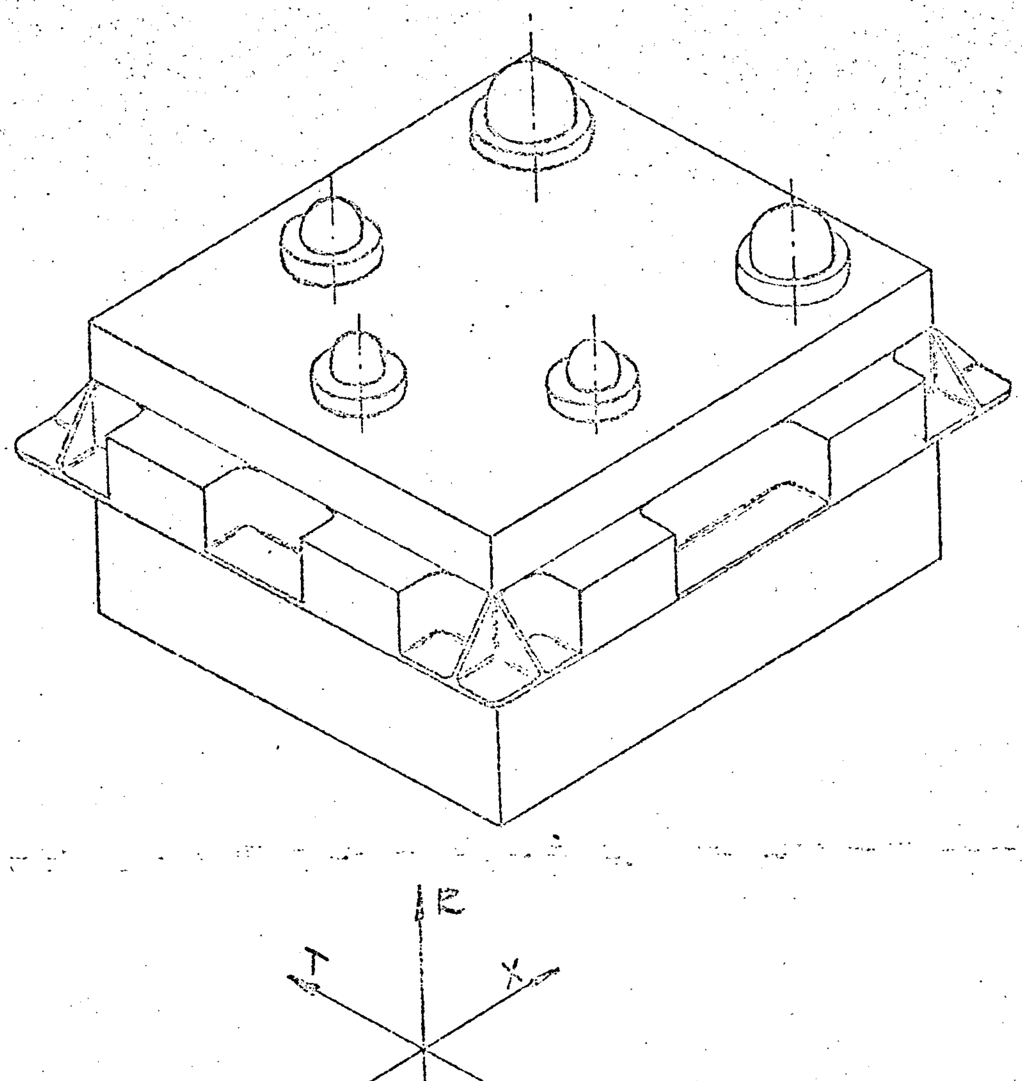


FIG. 1 – INSTRUMENT AXES.

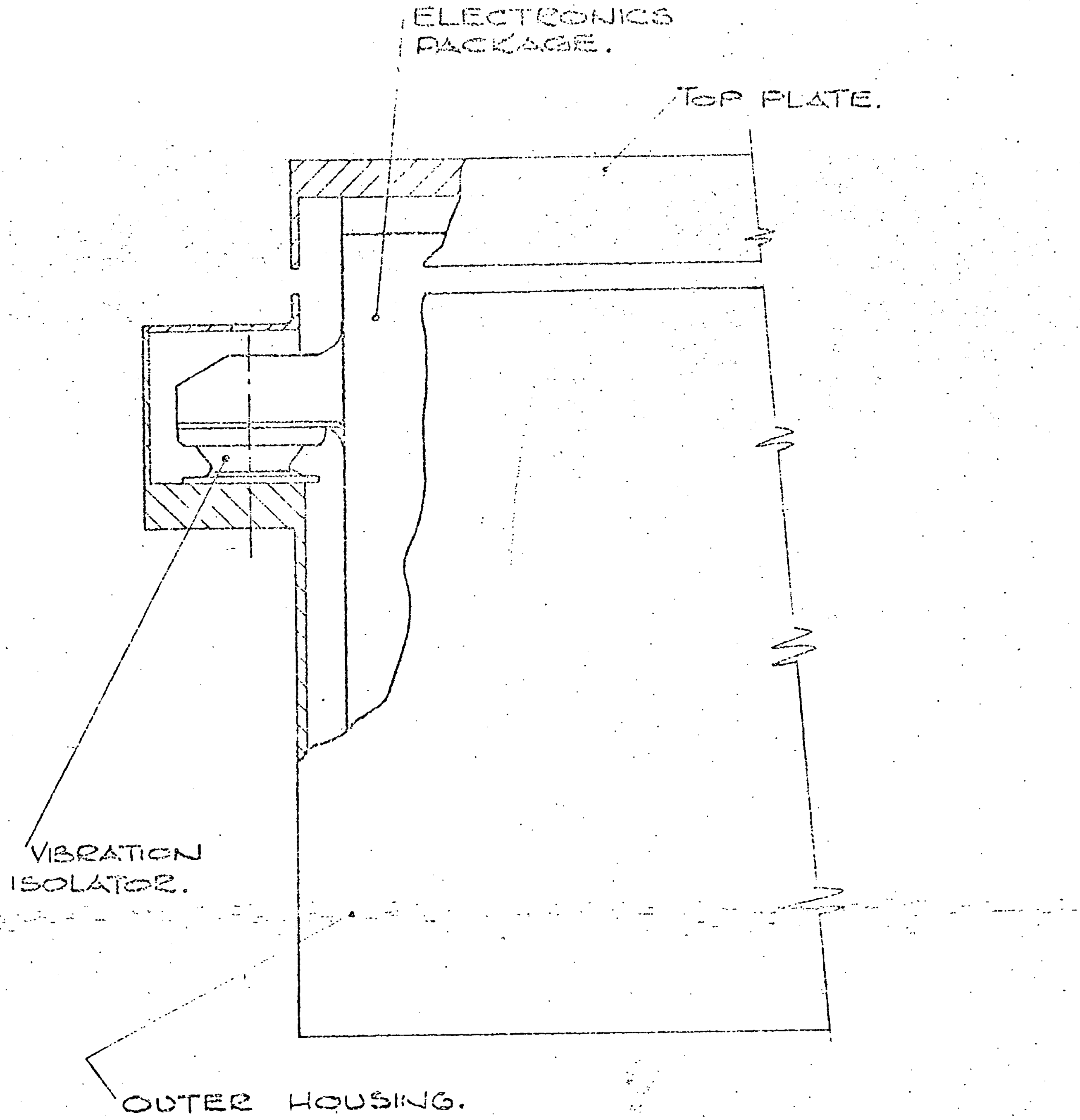
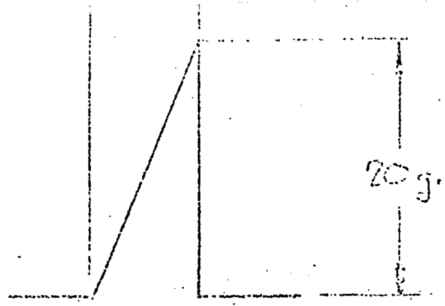


FIG. 2 - PACKAGE MOUNTING.



a. TEST SHOCK PULSE.

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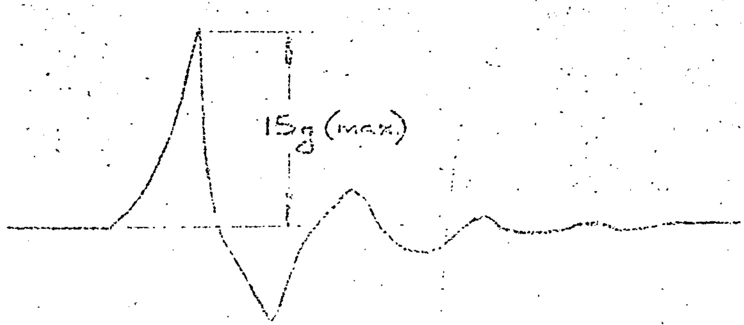
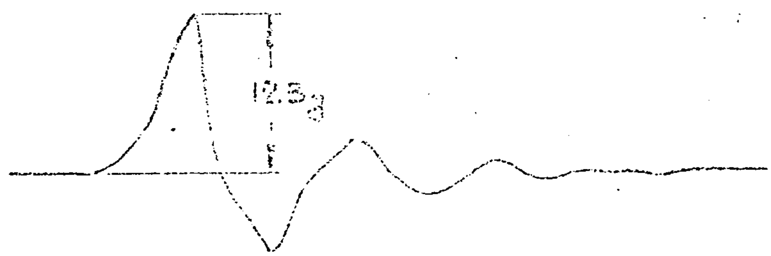
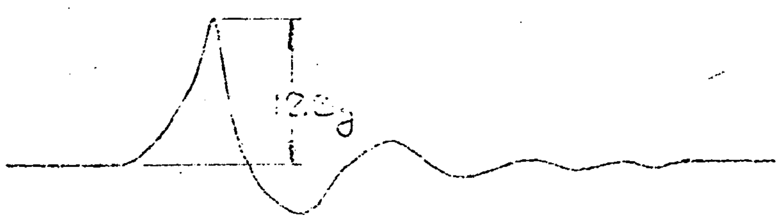


b. SHOCK RESPONSE - ELECTRONICS HOUSING, 'X' AXIS.



c. SHOCK RESPONSE - ELECTRONICS HOUSING, 'T' AXIS.



d. SHOCK RESPONSE - ELECTRONICS HOUSING, 'R' AXIS.

FIG. 3 TYPICAL SHOCK RESPONSES.

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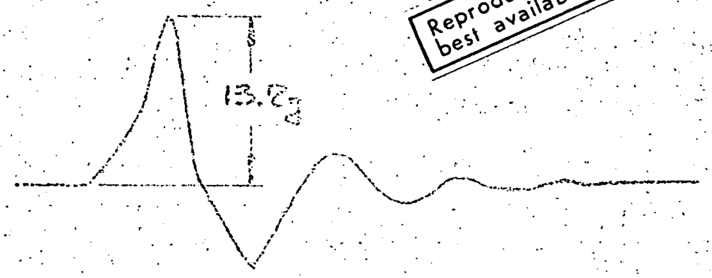
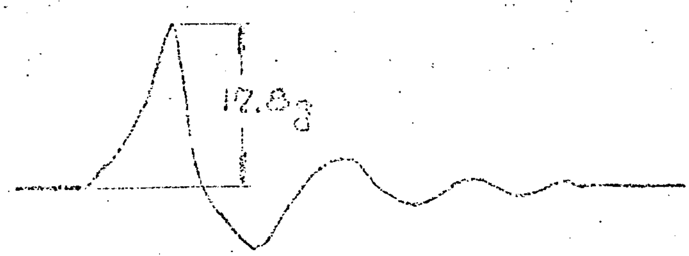


e. SHOCK RESPONSE - TEMP. MONITOR
P/C BOARD, 'R' AXIS.



f. SHOCK RESPONSE - DATA PROCESSOR
P/C BOARD, 'R' AXIS.

NOTE:- THESE TWO BOARDS GAVE MAX. RESPONSE IN
'R' AXIS VIBRATION.

FIG. 4 TYPICAL P/C SHOCK RESPONSES.